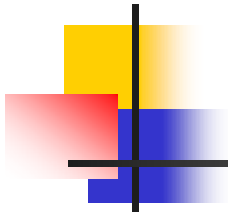


Plasmelt Glass Technologies, LLC

High Intensity Plasma Glass Melter

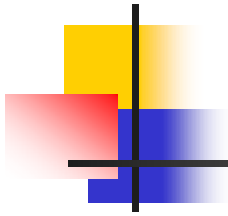
■ Agenda

- Project Overview (What was planned)
- Project Status (What we did)
- Plasma Melting Value to the Glass Industry
 - Results of marketing
- Initial glass quality / Next Steps
- Summary



Project Overview

- Build a transferred-arc plasma melter
- Establish baseline operation at 500 lbs/hour
- Determine market requirements
- Produce marbles (or patties/lenses) & fibers / test quality at partners site
- Commercialize process

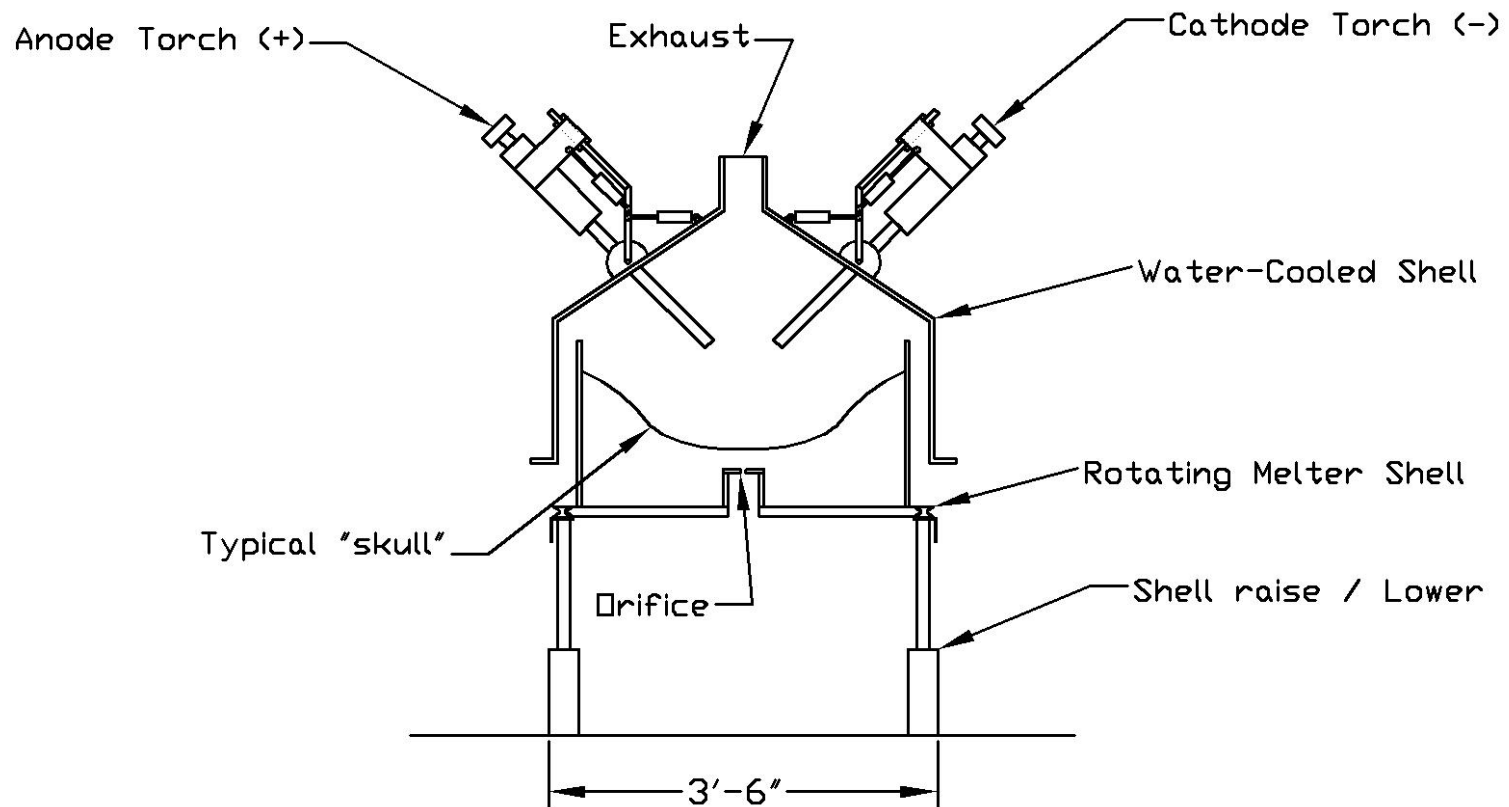


Project Overview

■ History

- JM developed technology in 90's
- Tested with scrap and batch melting
 - *E-Glass, S-Glass, Basement Scrap, Insulation, etc.*
- Tested and proved system works.
 - Results of testing:
 - Low throughput rates / low efficiency
 - High throughput rates / high efficiency / low torch life

Project Overview – As Proposed





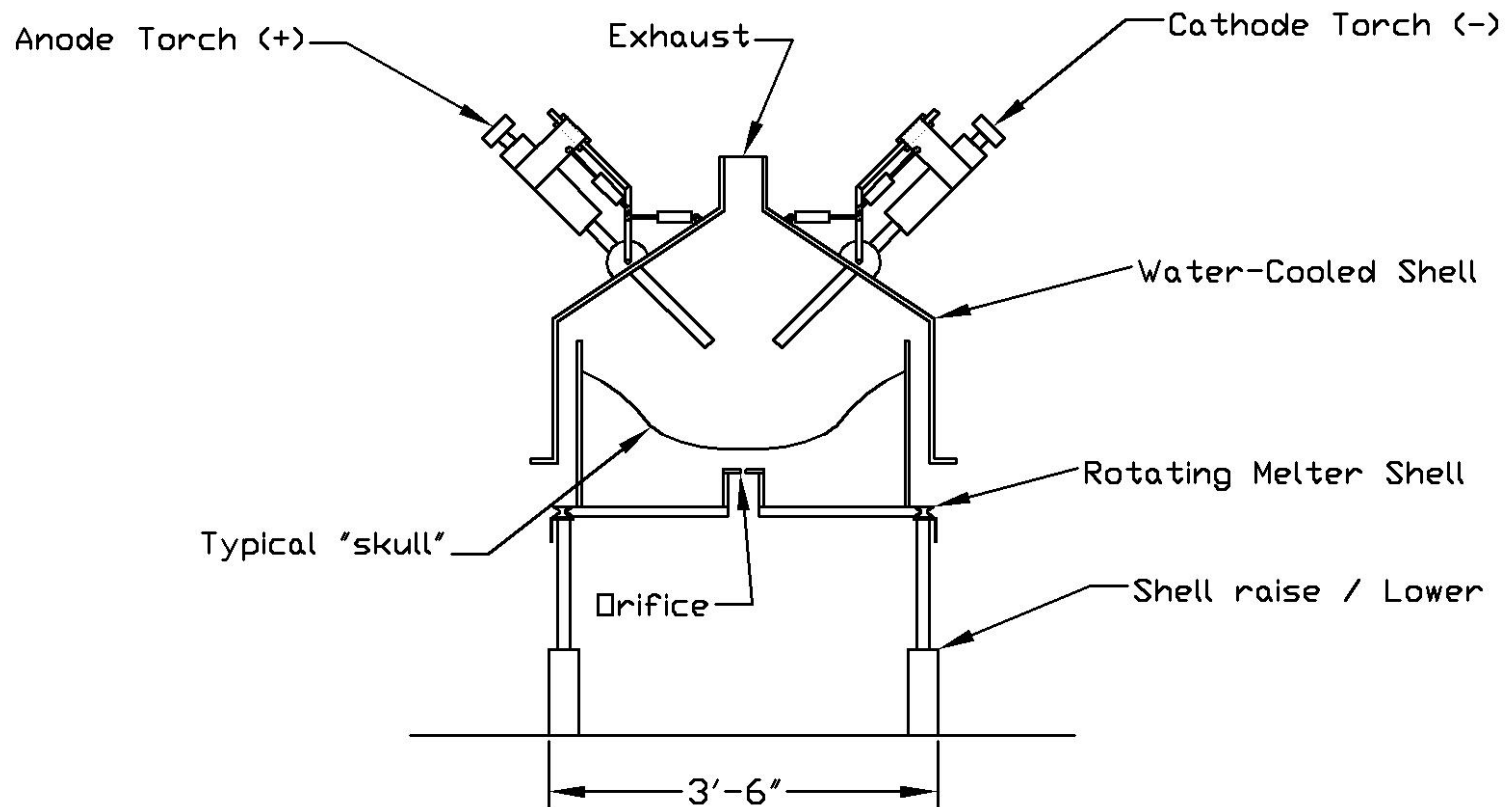
Project Status

- We designed and built research melter
 - Working on high-risk areas first
 - Robustness and looks come second
 - Rapid development cycle

Need to answer key questions:

- What is the maximum life of torches?
- Can it produce acceptable glass quality?
- Does anyone want this if we make it work?

Project Overview – As Proposed



Project Status – As built



Project Status – As built

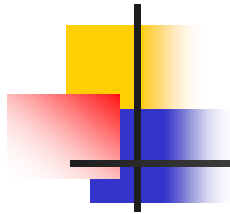


Project Status – As built



Project Status – As built





Project Status – As built

- Built entire system
 - Upgraded power / facility
 - Installed all equipment
- Built / tested over 50+ torches
- Built / tested over 14 orifice designs

Results are:

⇒ Ran melter at 200 lbs/hr for 2+ hrs with “stable” operating conditions



Project Status

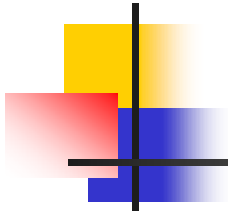
■ Project Plan – Year 1

	<u>Original</u>	<u>Actual</u>
Project Start	7/28/03	Complete
Facility Selection	8/21/03	Complete
Utilities / Facility Modifications	10/28/03	Complete
System Design	12/11/03	Complete
Construction	1/22/04	Complete
Initial testing	2/27/04	In Progress
Full-scale testing	5/30/04	In Progress
Market Study	5/31/04	Complete
Glass Cullet Testing	6/30/04	



Plasma Melting – Value to Glass Industry

- Energy Efficiency
- Production Flexibility
 - 20 min startups / stops
 - Can melt many different materials
 - Fast process response time
- Modular / Scalable
 - Can add additional melting capacity in modular blocks
 - Provide means of matching production requirements with market demand
- Ability to Quickly Start / Stop Process
 - Better power rates
 - Improved labor utilization



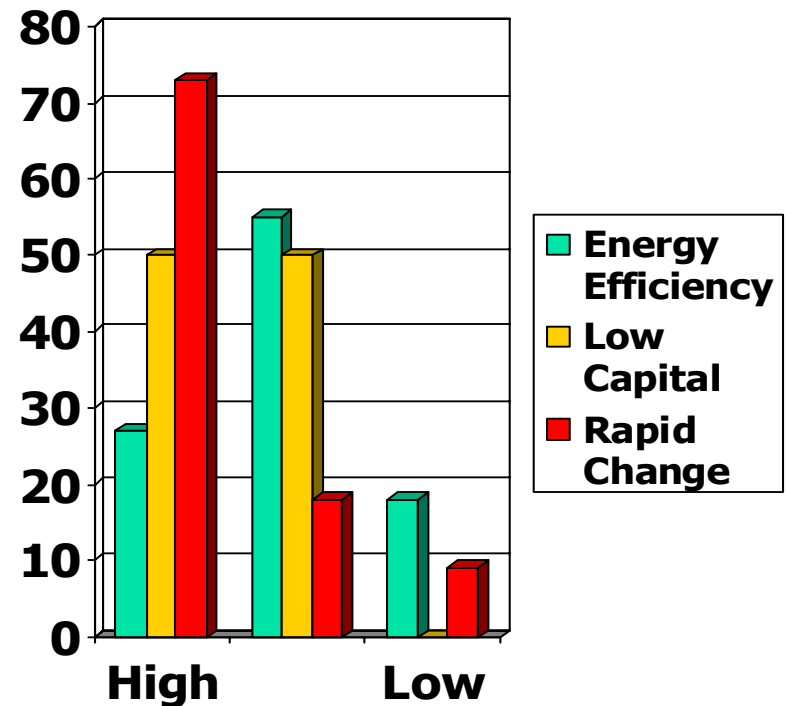
Plasma Melting – Value to Glass Industry

- Scrap Processing
 - Standard technology with ability to process several types of material
 - Ability to use same melter for batch melting and scrap processing
 - Industry-proven technology for processing scrap material
 - Landfill cost was very expensive
 - Potential long-term issues with landfill of big concern
- Low-capital system
 - Small
 - Modular
 - No refractory
- Capability to process new materials
 - Unique high temperature materials
- Small exhaust stream

Plasma Melting – Value to Glass Industry

■ Preliminary Market Study Results

- Highest priority benefits of the Plasmelt Melter are its rapid changeover capability and its low initial capital and maintenance costs
- Energy use is important. But, electric melting at 4.1 MM btu/lb is not perceived as a particularly low energy cost melting process.
- Environmental benefits, with the exception of the elimination of refractory disposal, are low in relative value to special glass segment companies interviewed. Ability to recycle waste with a plasma melter is important to several companies.
- New Materials / New Products / New Lines is a potential benefit of the high temperature capability of the plasma melter system.





Initial Glass Quality

Initial glass samples have not yet been sent to Integrex, but our cursory observations are:

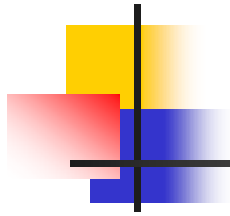
- The glass has abundant very small seeds (as expected).
- Cordy glass and minor amounts of un melted batch.
- No evidence of Moly in glass.
- High exit orifice temperatures are promoting volatilization.
- Volatilization is occurring from the E-glass exit stream.

Baseline suite of glass samples has been collected and are being prepared for:

1. Physical property test variation over time (e.g. viscosity, refractive index)
2. Glass chemical analyses (target vs actual)
3. Fiberizing trials

Final suite of glass samples will be submitted for a more detailed analysis:

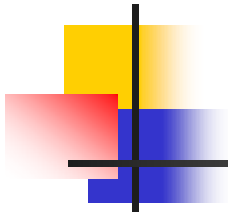
1. Fiberizing and fiber property testing
2. Homogeneity Testing: Shelyubski? Density spread? RI via Interferometry?



Known Obstacles

- Technical Obstacles:
 - Anode torch life
 - Glass Quality (mixing, refining, volatilization)

- Market Obstacle
 - No installed base in the glass industry
 - Process economics
 - Capital, abatement, power source, etc.



High Intensity Plasma Glass Melter -- GO 13093

BARRIER - PATHWAY - APPROACH

BARRIERS

- Torch Life
- Process Stability
- Energy Efficiency
- Glass Quality
- Market Acceptance

PATHWAYS

Development of Robust Torch Designs

Understand the relationship between process operation and process stability

Understand relationship between energy efficiency and process operations

Understand relationship between process operation and glass quality

Market Study & Technical Economic Analysis Tools

APPROACHES

Rapid turnaround time on torch trials and design evaluations

Conduct parametric trials to relate operational settings to exit temperatures and glass flow rates.

Conduct parametric trials to relate process settings to transferred arc energy

Conduct parametric trials to relate process settings to glass quality

Conduct market study of Specialty Segment and develop a TEA tool to use for marketing efforts



Next Steps based on initial glass quality

- Goal : Achieve 500 # / hr with a stable process at efficiencies of at least 4.1 MM / BTU / ton and with improved environmental impact
- Determine the relationship of furnace operation & glass throughput to glass quality & energy efficiency
- Outline a detailed plan and engineering feasibility study of first pilot installation at AGY
- Evaluate alternate higher melting glass compositions
(e.g. S-glass, Alumino-silicates, silica, etc.)
- Conduct fiberizing trials to establish the benefits/penalties
- Conduct energy balance of entire system
- Conduct environmental assessment



Summary—Plasmelt Year 2 Technical Efforts Being Driven by CSP's and Market Study Results

■ Technical Merit:

- Potential 25 to 40% energy savings
- Ability to rapidly changeover a melting operation (73% High Interest)
- Need – New technology / new markets
- Contribution of knowledge – Will generate first-ever data to relate glass quality to plasma melting process operation

■ Technical Progress:

- Progress – On track. On Budget. From nothing to melting 200 #/hr of glass in 9 months!!!
- Expectations for successful solution – See video



Summary

- Commercial Readiness in July, 2005:
 - Answer the three questions
 - Pilot engineering & feasibility study with AGY
 - Complete glass melting trials of various glass industry glasses
 - Demonstrate process stability, glass quality, energy and environmental
- Market Potential:
 - Broadness of application – melter design is generic
 - Adaptation potential – Low-cost / flexible solution



Summary

Programmatic Merit:

- Benefits – Lower cost of production on several fronts
- Resources - Best in industry
- Commercialization plan – Focused on profit and speed to market

Summary

Bottom Line

- **Proposal to glass melting in 9 months!**
- **We have completed an aggressive first year project plan.**
- **We are on budget / On schedule.**



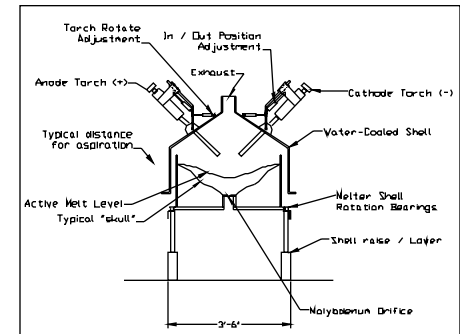
High Intensity Plasma Glass Melter -- GO 13093

Project Goal: Develop an efficient 500 lb/hr transferred arc plasma melting process that can produce high quality glass suitable for processing into a commercial article.

Challenge: Develop a torch design that will allow a stable and efficient process producing high glass quality.

Benefits: High energy efficiency, low initial capital cost/low maintenance cost, rapid changeover design, with high temperature capability for new and novel materials.

FY 05 Activities: Develop improved torch designs, conduct parametric trials to relate melter operation to energy efficiency, glass quality, and low environmental emissions. Evaluate scrap melting for fiberglass. Conduct engineering and feasibility study for first pilot installation.



PARTICIPANTS:

1. AGY
2. JM
3. J.K. Hayward
4. LGP
5. Integrex Laboratory
6. InnovaTech